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# TOWARDS A USABILITY MEASUREMENT FRAMEWORK FOR PROCESS MODELLING TOOLS

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## Abstract

*Usability is widely used in software engineering as a criterion of product quality and acceptance. Studies revealed that one dollar investment in usability brings 10 times more profit than investments in advertising. Usability of websites and desktop applications has been extensively investigated during the last decades. However, little was done in the area of usability of process modelling tools. We argue that generic usability measurement frameworks do not reflect the particularities of this type of applications. In our research-in-progress paper we have conducted a number of empirical studies in order to determine environment dimensions and their effect on usability attributes. As a result we propose a theoretical usability measurement framework whose underlying hypotheses will be evaluated in future research.*

*Keywords: Process Modelling Tools, Usability, Usability Measurement Framework*

# 1 INTRODUCTION

Conceptual modelling has been a widely and thoroughly discussed topic among academics and practitioners during the last decades (Mendling et al. 2008). Conceptual models are applied in practice for various purposes, such as database design and management, business process documentation and improvement, change management, knowledge management, end user training etc. (Davies et al. 2006). Models are constructed using graphical notations, e. g. Petri Nets, EPC, BPMN, IDEF or UML, which provide a set of elements, relations and rules for combining them. The market of modelling software is enormous, the products' functionality varies from simple drawing tools up to integrated environments, so called business process management suites (Gartner 2010).

In practice, the choice of a certain technique or tool depends on several factors, such as modelling purpose, usefulness or complexity of the technique (Davies et al. 2006). A commonly used theory in this area is the Technology Acceptance Model (TAM), which defines perceived ease of use and perceived usefulness as the core factors for technology choice and acceptance (Venkatesh and F. D. Davis 2000). User satisfaction is another important factor, which defines success or failure of a computer system usage (Conrath and Mignen, 1990; Ibaria and Nachman, 1990; Deng et al., 2010; Gatian, 1994; Chen et al., 2000; Al-Maskari and Sanderson, 2010). Furthermore, studies were conducted to explore the key influence factors regarding the usage and choice of a modelling technique. For instance, the usage behaviour of the Business Process Model and Notation (BPMN) has shown that only a small subset of language elements is actually applied in practice (Zur Muehlen and Recker 2008). Therefore, complexity is one of the aspects to be considered when choosing process modelling language. Schalles et al. (2011) investigate usability factors for model interpretation scenarios, in particular they claim learnability and perceptibility to be the most important variables that influence the efficiency of model interpretation. They conclude that these variables are impacted positively by visual variability and negatively by the complexity of the language, respectively (Schalles et al. 2011).

In accordance to TAM, we argue that the usability of conceptual modelling software plays an important role in practice for the acceptance of conceptual modelling. However, this tool-based perspective has been mostly neglected in literature, as there are only studies that compare tools according to a specific usage scenario (Gartner 2010; Riemer et al. 2011) or surveys on the most widely used conceptual modelling tools in practice (Davies et al. 2006). In order to add to the body of knowledge we are conducting an empirical study to reveal the factors that influence the usability of conceptual modelling tools. In particular, we seek to answer the following questions:

- (RQ1) *Which usability attributes (learnability, memorability, effectiveness, efficiency, user satisfaction) are relevant for process modelling tools?*
- (RQ2) *Which attributes of a process modelling environment affect the process modelling tool usability attributes?*

The remainder of this paper is structured as follows. Existing studies on usability measurement are discussed in section 2. Section 3 describes our research design. Subsequently, the theoretical framework for usability measurement of process modelling tools is developed and discussed in chapter 4. We conclude our paper with the outline of upcoming research steps in chapter 5.

## 2 RELATED WORK

Usability is a concept widely used in software engineering when talking about interface design and quality of interactive systems (Bastien, 2010; Kushniruk and Patel, 2004; Insfran and Fernandez, 2008; Nielsen, 1993). There are several definitions of usability. ISO 9241-11 defines the usability as an extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO 1998). Similar to the ISO

9241-11 definition, the MUSiC project defines usability as the quality of interaction in a particular context, which is measured by effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments (Bevan 1992). IEEE defines usability as ease of learn and use, as well as users' productivity and amount of support needed when working with a software (IEEE 1990). Shackel (1991) mentions speed, time to learn, retention, errors and the user specific attitude. From these definitions it becomes clear that usability is a multi-dimensional concept, composed of the attributes defined in Table 1:

<b>Attribute</b>	<b>Definition</b> (Seffah et al., 2006; Nielsen, 1993; Kushniruk and Patel, 2004; Bastien, 2010)
Learnability	How easy is it for the users to learn the functionality of the software.
Memorability (retention)	How long can the user remember the functionality of the tool while using it on an irregular basis.
Effectiveness	The accuracy and completeness with which users achieve specified goals.
Efficiency	Resources expended in relation to effectiveness (e. g. time, money, mental effort).
Satisfaction	Freedom from discomfort and positive attitudes towards the use of the product.

*Table 1. Usability Attributes*

Most of the literature on usability places these dimensions on one causal level and do not regard possible interdependencies between the attributes (Bevan 1992; Abran et al. 2003). However Schalles et al. (2011) have proven that there are correlations between usability attributes for the case of measuring usability of modelling languages on the example of EPC and BPMN. In particular, there is a strong positive correlation between learnability and efficiency and a weak negative correlation between memorability and efficiency, as well as strong positive correlation between efficiency and user satisfaction (Schalles et al. 2011). Studies have also shown positive correlation between user satisfaction and effectiveness (Deng et al., 2010; Gatian, 1994; Al-Maskari and Sanderson, 2010).

Usability measurement is performed within a particular context of use and requires consideration of several components, such as user, task and environment (Conrath and Mignen, 1990; Kushniruk and Patel, 2004; Bastien, 2010; Bruno et al., 2005). This interdependency is reflected in usability measurement frameworks. The framework proposed by Shackel (1991) took the user, task, tool and environment into consideration. A more generic framework is provided by the ISO 9241-11 standard, which demands the following information for measuring usability: the description of intended user goals and the description of the components of the context of use including user, task, equipment and environment (ISO 1998). The MUSiC methodology for usability measurement (Bevan et al. 1992) is structured similar to the ISO standard. However, it distinguishes between the organizational, technical and physical environment in the context of use and omits the task and goal definitions.

The above mentioned frameworks are generic and can be applied for the task of usability evaluation of any software product. We, however, argue that for the usability evaluation of process modelling tools, specific aspects, such as modelling methodology or tool specific characteristics, have to be considered which are not mentioned in the generic usability frameworks.

### 3 RESEARCH DESIGN

Our research strategy is based on a mixed research method (Bryman and Bell 2007) including qualitative and quantitative research tasks as depicted in Figure 1.

- As a preparatory step, we have conducted a market study in order to enrich and objectivise our knowledge about the characteristics of business process modelling tools available on the market.
- The results of the market study were then used as a basis for interviews with 17 business process modelling experts from academia and practice. The results of the interviews helped to unfold the usability attributes of business process modelling tools (RQ1).
- Thereafter, a web-based survey was conducted to disclose process modelling tool and context attributes, which have a significant effect on the usability attributes (RQ2).

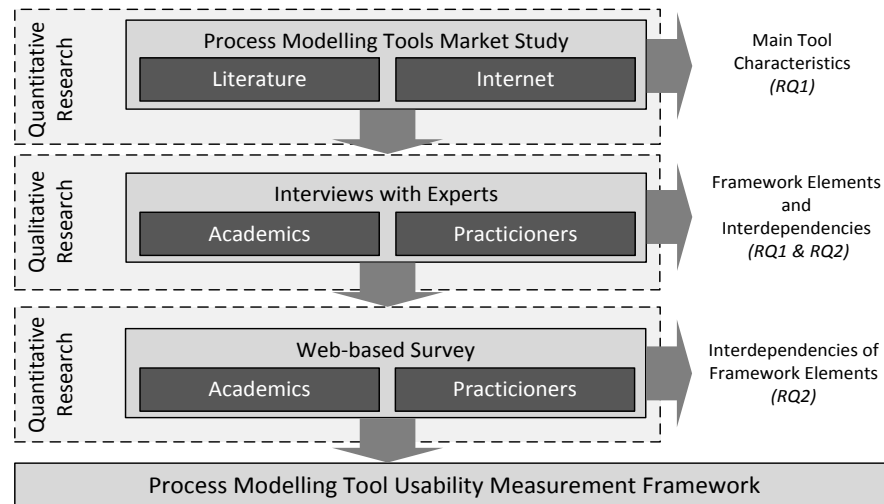


Figure 1. Research Design

### 3.1 Market Study

To unfold the functionality provided by process modelling tools available on the market we analysed a representative sample of tools. Therefore, we undertook an online search using the search terms ‘Business Process Modelling Tool’ and ‘Process Modelling Tool’. Based on the first 100 hits we ended up with a list of 73 tools. Twenty of these tools were not further analysed, because the necessary information could not be retrieved. The reason for this was mainly that the tool was either merged into another tool, was out of business or not maintained anymore. The remaining tools were thoroughly studied and compared based on the classification scheme shown in Table 2.

Dimension	Criteria
General	Version, Vendor, Market entrance, Price model, Reference customers
Functionality	Modelling, Reporting, Simulation, Analysis
Modelling	Notation/Method, Reference models, Structure, Attribution/Extensibility, Hierarchies modelling, Version management, Model comparison
Collaboration support	Concurrent modelling, Internal communication, Comments, Repository, User and rights management, Client management
Technical Aspects	Platform/Architecture, Technologies, Export, Import
User Interface and Assistance	Documentation, Consistency, User Interface, Exception Handling, Complexity, Adaptability

Table 2. Market Study Dimensions used for Tool Classification

### 3.2 Interviews

The interviews were conducted with 17 business process modelling experts from academia (8) and consulting practice (9). The interview partners were directly contacted by the authors because of their background in practice or academia. Only the participants with a significant high level of knowledge in business process modelling and particular good experience with business process modelling tools were invited to take part in the survey. Each interviewee was interviewed by two interviewers. While one interviewer moderated the discussion, the second interviewer took notes. The interviews were recorded unless the interviewee declined the permission to record, which only happened in one case. Based on the notes and the audio recording a detailed protocol was prepared for each interview.

The interviews were semi-structured following an interview guideline which was inspired by the market study findings. Especially, hypotheses regarding the usability features, e. g. documentation, consistency issues, or the graphical user interface, could be discussed within the interview more

thoroughly. The focus of the discussion was, therefore, on the dimensions for efficient and effective usage of the tool, easiness to learn and retain the tool's functionality, as well as the satisfaction from the tool usage (RQ1 & RQ2). The information derived from the interviews served as a basis for the construction of a preliminary usability measurement framework as shown in the next section.

### 3.3 Web Survey

After analysing the interview results we intended to cross-check our preliminary assumptions regarding the usability attributes and their interrelations. For this purpose, a self-completion web survey was conducted, which aimed at clarifying the interrelationships between process modelling environment and the process modelling tool usability attributes (RQ2).

The survey was composed of 26 research related questions. Table 3 presents the categorization of the questions relevant for the research questions. Most of them were fixed-choice questions with a pre-coding for simple analysis (Bryman and Bell 2007). In case we asked the respondent for agreement or disagreement regarding a certain statement a Likert-Scale (Likert 1932) was used.

Within a little less than four weeks we got 43 valid international respondents. The assumption of a high level of knowledge in the area of business process modelling and respective tools of the respondents was confirmed by 72.7% of them classifying their experience level as advanced or expert.

Category	Sample Question	n
Experience level	Beginner/advanced/expert	43
Known tools	Choose from the list of the tools (market study sample, 50 tools)	43
User assistance	Manual (external); integrated help system; (video) tutorial; test access/demo version; context menu (right click); tooltips	43
User interface	Simplicity and consistency of the control elements; clarity of the interface; understandable feedback (advices, error messages); quick familiarisation; adaptability/personalisation; performance (reaction time, loading time); drag & drop; keyboard shortcuts	43
Process modelling	Intuitive modelling; meaningful process structure; clear structure of the process layers; integrated reference model; consistent and uniform naming of the elements; modelling of organisational structures; modelling of the IT-architecture	43
Additional features	Would you use mobile devices for process modelling?; Do you need integrated simulation?; Do you need integrated workflow management?; Do you need integrated reporting?	43

Table 3. Web Survey Questions and their Categories

## 4 FRAMEWORK DEVELOPMENT

### 4.1 Framework Elements

In Figure 2, the designed framework for measuring usability of process modelling tools is presented. The ISO 9241-11 usability measurement framework (ISO 1998) served as a basis and was extended according to the results of the literature review and the market study, interviews and web survey. The framework consists of two main parts: environment and usability attributes, which in its interrelations impact the overall tool acceptance.

The environment part is defined by the tool itself and the tool's context of use. These two elements can be found in the ISO 9241-11 framework (ISO 1998) as well as in the earlier framework from Shackel (1991) and MUSiC framework (Macleod and Bowden 1997), however they had to be changed and adapted for the scenario of evaluating process modelling tools. Context of use contains three attributes:

- *Task complexity*: as it was shown by interviews there are different tasks to be done during business process modelling projects, ranging from simple process creation to model analysis

or simulation. The choice of the modelling tool and technique and its usability level are proven to be dependent on the user task characteristics (Batra and Srinivasan, 1992; Bruno et al., 2005; Aguilar-Savén, 2004). We define *complexity* as a measurement characteristic for the task attribute, where, for instance, model analysis is a more complex task than model creation.

- *Modelling methodology*: often tools support not just one, but several process modelling languages (e.g. UML activity diagrams, EPC, BPMN etc.) which differ with respect to number of elements and attributes as well as modelling rules and constraints. Schalles et. al (2011) have already proved that modelling language complexity has an impact on understanding the resulting models. Batra and Srinivasan (1992) have found that the choice of the data modelling method affects user performance when using data management environments. We want to examine the impact of modelling methodology *complexity* on the process modelling tool usability.
- *User experience* in conceptual modelling plays a significant role in usage of modelling tools. We classify users in three groups – beginners, who have just started with process modelling; experienced users, who have already performed some process modelling projects and tried several tools and modelling languages; and experts, who have a solid experience in the area of process modelling. Other usability and user satisfaction evaluation studies have also defined user characteristics as an important influencing factor (Batra and Srinivasan, 1992; Ibaria and Nachman, 1990; Bruno et al., 2005).

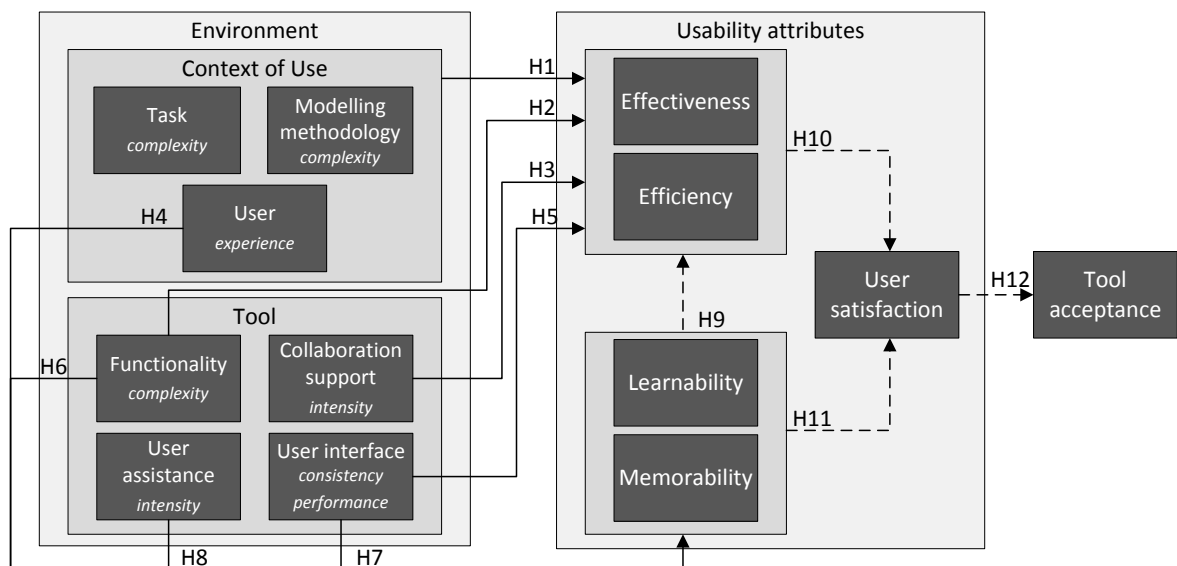


Figure 2. Usability Measurement Framework

The second element in the environment part is the process modelling tool itself. According to the market survey and interviews the following four attributes were assigned to the tool:

- *Functionality complexity* is comparable to the task attribute in the context of use element. For example, Microsoft Visio allows users to create and store the models in an unstructured manner, whereas Signavio<sup>1</sup> provides functions for model collection management and the possibility of analysis and reporting.
- *Collaboration support intensity* – collaboration support is important when a modelling project is conducted by a (distributed) team of modellers. Intensity of collaboration support is defined

<sup>1</sup> <http://www.signavio.com/>

by the type of features available in the tool, for instance multi-user access support, version management, internal model discussions etc.

- *User interface consistency* and *performance* define the quality of user interface design and general tool performance. The design of the screens, menus, and error messages has to be analysed when measuring the consistency of the user interface. Tool performance includes such evaluations as operation execution time, frequency of system errors occurrence, etc.
- *User assistance intensity* is defined by the type of user support in modelling activities (e.g. syntax or terminology check) and tool usage (e. g. different kinds of help, documentation and tutorials, or personal assistance) provided by the process modelling tool. User support was defined as one of the impact factors on user satisfaction in case of data warehouses (Chen et al., 2000).

Usability attributes contain all five attributes defined in the related literature part (Table 1). Additionally we have grouped efficiency and effectiveness as well as learnability and memorability attributes together. Based on the knowledge derived from the interviews, we argue that these attributes are most likely to be affected together with the same environmental attributes as a whole. Based on the idea from Schalles et al. (2011), we have assumed that there exist certain dependencies between usability attributes. These dependencies are reflected by the dashed lines in the framework diagram.

Finally, we have extended the usability measurement framework with technology acceptance evaluation. As already stated in the introduction, perceived ease of use and perceived usefulness are the core factors for technology choice and acceptance (Venkatesh and F. D. Davis 2000). Usability is a narrow concern compared to system acceptability (Nielsen 1993). Therefore, we do not claim that usability fully defines tool acceptance, but it is one of the influencing factors. This reasoning is supported by a number of models and theories of individual acceptance, which mention some of the usability attributes as influencing factors of technology acceptance (Venkatesh et al. 2003).

## 4.2 Framework Hypotheses

During the framework design we have raised a number of hypotheses regarding the causal relations between the elements in the framework. These hypotheses are presented in Table 4 and are based on the results of the literature review, market study, web survey and expert interviews.

During the interviews we discussed if a modelling tool which basically only supports process modelling and presenting the resulting models is of interest for a process modelling project. Some interviewees preferred having one single tool for process modelling, workflow management and simulation. Nevertheless, the majority clearly argued for separating these, since an extended data set is required for supporting all functions which is hardly present in modelling projects in a reasonable quality. The same holds true for analysis and reporting functionalities which were expected as essential for a process modelling tool – at least in a simple way with standard reports, search functions and simple aggregation of times or costs. Irrespective of the range of the functionality, we argue that it is a key tool attribute which influences the effective tool usage (H2), tools' memorability and learnability (H6) according to its complexity.

Furthermore, the interviewees agreed that a consistent, clear and simple graphical user interface is easy to comprehend and use (H5 and H7). For example, the possibility of using drag & drop for positioning or repositioning (several) model elements was mentioned as the most important tool feature, beside the copy & paste or shortcuts feature.

Performance is no issue as long as the performance is perceived high enough for efficient working with the tool. Thus, performance is crucial for efficient modelling (H5). Therefore, it is taken into account for the framework as key tool attribute with an impact on efficient model creation and maintenance. The same result can be found in a previous study by Deng et al. (2010) who state that basic IT quality dimensions are just preconditions for user satisfaction, which means that in case of



inappropriate tool performance the user will refuse to work with the tool, but the tool quality alone is not enough to ensure high user satisfaction.

The more advanced our interviewees were, the less they were reliant on assistance (H4). Nevertheless, a complete and understandable documentation is important for memorability and learnability especially for modelling beginners and their first modelling experiences (H8). The type of the material, e. g. video tutorial, tooltips or text-based documentation, is not as important as the context of the documentation. In the best case, the user intuitively uses the tool without an error. But in case the user encounters an error, a context-sensitive understandable error feedback fosters efficient modelling (H3).

#	Hypothesis
(H1)	The elements of context of use affect effectiveness and efficiency.
(H1a)	Task complexity has a negative impact on effectiveness and efficiency.
(H1b)	User experience has a positive impact on effectiveness and efficiency.
(H1c)	The modelling methodology complexity has a negative impact on effectiveness and efficiency.
(H2)	Complexity of the tool's functionality positively affects the effectiveness and efficiency of process modelling tool usage.
(H3)	Intensity of collaboration support positively influences the efficiency and effectiveness of process modelling tool usage.
(H4)	User experience has a positive impact on memorability and learnability attributes.
(H5)	User interface consistency and performance positively affect efficiency and effectiveness.
(H6)	Complexity of the tool's functionality has a negative impact on learnability and memorability of the tool.
(H7)	User interface consistency influences positively the learnability and memorability of the tool.
(H8)	User assistance intensity is positively related to the learnability and memorability.
(H9)	Learnability and memorability positively affect effectiveness and efficiency of tool usage.
(H10)	Effectiveness and efficiency have positive impact on user satisfaction.
(H11)	Learnability and memorability positively affect user satisfaction.
(H12)	There is positive correlation between user satisfaction and tool acceptance.

Table 4. *Hypotheses regarding the Usability Measurement Framework*

## 5 OUTLOOK

In this research-in-progress paper we aimed at designing a framework for measuring the usability of process modelling tools. This topic is not widely discussed in the research community, so we have tried to elaborate on the theoretical aspects of usability taken from the software engineering discipline and find out which usability attributes are relevant for process modelling tools (RQ1) and which environmental elements affect these usability attributes (RQ2).

We have conducted a market survey to find out more about existing process modelling tools on the market. The interviews and web survey have been conducted to learn more about the importance of process modelling tools functionality and their correlation to the usability attributes.

As a result, we have proposed a theoretical framework for measuring process modelling tools usability. Twelve hypotheses about the interrelation of framework elements were stated, which have to be proven for statistical significance during the future research.

As the next research step, we plan to evaluate the framework. For this purpose we will conduct experiments to collect data for measurement of the framework elements and then apply statistical methods to test which hypotheses in the framework appear to be valid. After this, the framework will be adjusted if needed. In the end we aim to get practical implications for process modelling tool design and implementation.

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